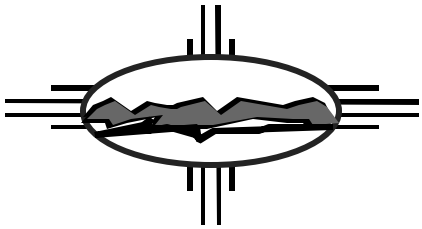
STANDARD OPERATING PROCEDURE

Title:	Identifier:	Revision:	Effective Date:
Tensiometer (Soil Suction Monitor) Installation and Measurement	**ER-SOP-6.06**	**1**	**03/08/99**



ER PROJECT

APPROVALS FOR USE

Author's Name (Print):	Author's Signature:	Date:
Jennifer Pope	**Signature on file**	**03/08/99**
Quality Program Project Leader's Name (Print)	Quality Program Project Leader's Signature	Date:
Larry Maassen	**Signature on file**	**03/08/99**

LOS ALAMOS NATIONAL LABORATORY

Tensiometer (Soil Suction Monitor) Installation and Measurement

Table of Contents

Tensiometer (Soil Suction Monitor) Installation and Measurement

NOTE: Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled document electronic file. However, it is their responsibility to ensure that they are trained on and utilizing the current version of this procedure. The procedure author may be contacted if text is unclear.

1.0 PURPOSE

This Standard Operating Procedure (SOP) defines a method of placement, installation, and operation of soil suction monitors (tensiometers) for the proper measurement of soil moisture potential for use by the ER Project.

2.0 TRAINING

The **Field Team Leader** (FTL) is responsible for ensuring that field team members who operate tensiometers for the ER Project are properly trained. In addition, all field team members who use this procedure shall be familiar with the objectives of the sampling program and must document that they have read and understand this procedure in accordance with QP-2.2.

3.0 DEFINITIONS

3.1 *Potentiometer* — An instrument for measuring an unknown potential difference by comparison to a standard potential difference.

3.2 *Site-Specific Health and Safety Plan (SSHASP)*—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

3.3 *Soil hygrometer* — An instrument that measures soil moisture.

4.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

4.1 The Site-Specific Work Plan contains specific details about the procedures and equipment used for this SOP. Refer to the plan for the type of samples to be collected. Collection and measurement of samples and the documentation of data will be performed as described in the associated procedures.

4.2 A specific discussion of tensiometer locations, installation depths, sampling methods, and other details with regard to the deployment of tensiometers at installation sites is contained in the Site-Specific Work Plan.

5.0 EQUIPMENT

A checklist of suggested equipment and supplies employed to implement this procedure is provided in Attachment A. Attachment B shows the components of a tensiometer, Attachment C details the vacuum gauge, and Attachment D contains the form and the instructions for recording data.

5.1 The tensiometer (also known as capillary potentiometer, soil hygrometer, or soil moisture meter) is an instrument that provides a direct measurement of the negative pressure potential or suction in a soil. Tensiometers are used when it is necessary to measure the gradient in pressure potential to determine the direction and rate of water movement in a soil profile.

5.2 The tensiometer measures the matric potential (capillary potential) of a soil for suction values between 0.1 and 1 bar. The measured matric potential can be used with soil moisture content data to construct a characteristic curve of soil moisture for vadose-zone characterization and modeling.

6.0 PROCEDURE

Note: Deviations from SOPs are made in accordance with QP-4.2.

6.1 Preoperation Activities

6.1.1 Assemble the equipment and supplies listed in Attachment A. Ensure that all sampling equipment operates properly.

6.1.2 Pack tensiometers so that dial gauges and ceramic tips are not damaged during shipment to the site.

6.1.2.1 Wrap individual tensiometer pieces separately in paper and pack the tensiometers securely inside the shipping boxes.

6.1.2.2 Keep ceramic tips from contacting grease or similar material that would clog the pores.

6.2 Assembly and Filling

The component parts of a tensiometer are shown in Attachment B. To assemble the tensiometers, follow the steps below.

6.2.1 Before assembling the tensiometer, make sure all parts are clean and have not been damaged in shipping. Do not use any damaged equipment.

6.2.2 Screw the vacuum dial gauge into the threaded port in the side of the body tube until the backup washer on the stem body touches the body tube. Do not overtighten the dial gauge in the body tube—the O-ring on the stem ensures a tight vacuum seal.

6.2.3 Screw the ceramic tip into the body tube to the desired length.

6.2.4 Before you use the tensiometer, vent the dial gauge by momentarily removing the vent screw in the center of the dial-gauge cover. This will adjust the dial gauge to local conditions; the gauges are usually set at sea level atmospheric conditions.

6.2.5 Use distilled water or a fluid specifically prepared to inhibit algae growth, which shows as air bubble accumulation, to fill the tensiometers. Allow the tensiometer body tube to remain in a vertical position until the fluid completely saturates the ceramic tip and drips from the end of the tip for about 5 min.

6.2.6 Once the tip is saturated, fill the tube completely with distilled water and pull a vacuum within the top of the tensiometer with the vacuum hand pump.

6.2.6.1 After each pumping with the vacuum hand pump, refill the tensiometer completely to the top with water.

6.2.6.2 Repeat pumping four or five times or until no further air is seen bubbling from the stem of the dial gauge.

6.2.6.3 If the hand pump is not available, air can be adequately removed from the tensiometer by pushing the reservoir button down repeatedly after the tensiometer and reservoir have been filled.

6.2.7 Screw the reservoir fill cap into the top of the body tube.

6.2.8 Peel the neoprene reservoir cover back and fill the reservoir with distilled water until it is approximately 75% full. Replace the neoprene cover back over the reservoir fill cap and push the reservoir button (Attachment B) down several times to remove air from the reservoir pump cylinder and any accumulated air in the tensiometer.

6.2.9 Repeat the vacuum/pumping operation four or five times until there are no further air bubbles present in the stem of the vacuum gauge.

6.2.10 Because commercial gauge-type tensiometers generally are not corrected for the length of the tensiometer, adjust the dial on the vacuum gauge to zero (Attachment C) when you have immersed the tip of the tensiometer in water.

6.2.11 If the tensiometer will not be installed immediately, store it with the ceramic tips immersed in distilled water or covered with a plastic bag to prevent evaporation.

6.3 Installation

6.3.1 Install tensiometer in the desired location with good contact between the ceramic tip and native soil.

6.3.1.1 In soft, friable soils, push the shorter tensiometers directly into the ground.

6.3.1.2 In firm soils, bore a hole in the soil to accept the tensiometer. The hole must be the right size for a snug fit between the ceramic tip and the soil. An insertion tool or length of standard 0.5-in. water pipe may be driven into the soil to create the hole.

6.3.1.3 If you encounter rocky soil, seek an adjacent location for more workable soil. If you must sample in rocky soil, then use a 4-in. soil auger to bore a hole for the a tensiometer. Pass the removed soil through a 0.25-in. screen to remove large pebbles and rocks. Replace the screened soil as close to its original position as possible.

6.3.1.4 For deep installations or installations in rocky soils, produce a slurry of water and clean silica flour and pour it into the bottom of the hole. Push the ceramic tip into the slurry to ensure good contact in the soil. Pull up gently on the probe to check the strength of the suction. Repeat this step if probe releases easily.

6.3.2 Backfill (as necessary from Sections 6.3.1.3 and 6.3.1.4) around tensiometer body tube with native soil removed in the boring process. Backfill soil should be passed through a 0.25-in. screen to remove large pebbles and rocks. Tamp the soil down around the tensiometer to guard against water channeling down the hole. The soil around the tensiometer should not be compacted too tightly during installation.

6.3.3 After installation, it may take several hours for the tensiometer to accurately read the correct soil suction value. Additional time may be

required when a slurry is used. The correct value will be known when the water in the ceramic tip has come into equilibrium with the soil solution and the vacuum gauge reads a constant value. Correct readings will be reached more quickly in moist soils than in dry soils.

6.4 Field Measurements

Most tensiometers have a dial-type manometer to indicate the pressure potential. The scale is measured in centibars, from 0 to -100. Record tensiometer pressure potentials on the Tensiometer Sampling Field Data form (Attachment D). Follow the data completion instructions included after the form. The information on Attachment D may also be recorded in the Daily Activity Log form (Attachment E in ER-SOP-1.04). For additional comments, use the Daily Activity Log form.

6.5 Gauge Calibration

6.5.1 The tensiometer suction pressures are measured with a Bourdon tube gauge. These gauges are calibrated by the manufacturer. The zero setting of the gauges may be rechecked after the tensiometers are taken out of the soil (before the onset of freezing conditions) by placing the ceramic tip in distilled water. The gauge should read zero.

6.5.2 Check, recalibrate, or replace tensiometers when

- the tensiometer has been subject to subfreezing conditions or
- the gauge exhibits evidence of physical damage.

Record all calibration information on the Daily Activity Log form (Attachment E in ER-SOP-1.04).

6.6 Freezing Conditions

Before the onset of freezing conditions, remove tensiometers from each site. Unscrew the jet-fill reservoir cap and vacuum dial gauge, clean and store them where temperatures stay above freezing. Leave the ceramic tip and body tube in place; they can be used during the next season. Place a plastic cover over the opening of the body tube; leave the polyvinyl chloride (PVC) casing and cap in place.

6.7 Postoperation Activities

6.7.1 Ensure that all equipment is accounted for; decontaminated (according to ER-SOP-1.08); and ready for shipment.

6.7.2 Make sure all sampling locations are properly staked and each location ID is readily visible on the location stake.

6.7.3 Return the equipment to the equipment manager. Report any malfunction or damage.

6.7.4 Deliver all forms to the FTL.

7.0 REFERENCES

The following documents have been cited within this procedure.

QP-2.2, Personnel Orientation and Training

QP-4.2, Standard Operating Procedure Development

QP-4.3, Records Management

ER-SOP-1.04, Sample Control and Field Documentation

ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment

8.0 RECORDS

The **FTL** is responsible for submitting the following records (processed in accordance with QP-4.3) to the Records Processing Facility.

8.1 Completed Tensiometer Sampling Field Data form

8.2 Record of all details, including calibration, on the Daily Activity Log form

8.3 Sample Collection Log forms

8.4 Chain-of-Custody/Request for Analysis Forms

9.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Tensiometer Equipment and Supplies Checklist (1 page)

Attachment B: Component Parts of a Tensiometer (1 page)

Attachment C: Adjusting the Vacuum Gauge Dial (1 page)

Attachment D: Tensiometer Sampling Field Data (form and completion instructions) (3 pages)

Tensiometer Equipment and Supplies Checklist

		Condition	Quantity
_____	Tensiometer tubes of:		
	6 inches in length	_____	_____
	12 inches in length	_____	_____
	18 inches in length	_____	_____
	24 inches in length	_____	_____
	30 inches in length	_____	_____
	36 inches in length	_____	_____
	42 inches in length	_____	_____
	48 inches in length	_____	_____
	60 inches in length	_____	_____
	Other lengths:	_____	_____
	Total number of Tensiometer tubes		_____
_____	Vacuum dial gauges	_____	_____
_____	Ceramic tips	_____	_____
_____	Reservoir fill caps	_____	_____

_____ 4-in. soil auger

_____ Insertion tool

_____ ¼-in. soil screen

_____ Vacuum hand pump

_____ Other tools: _____

_____ Distilled water (Quantity: _____)

_____ Tensiometer Sampling Field Data forms

_____ Daily Activity Log forms

_____ Chain-of-Custody/Request for Analysis Forms

_____ Sample Collection Log forms

_____ Variance logs

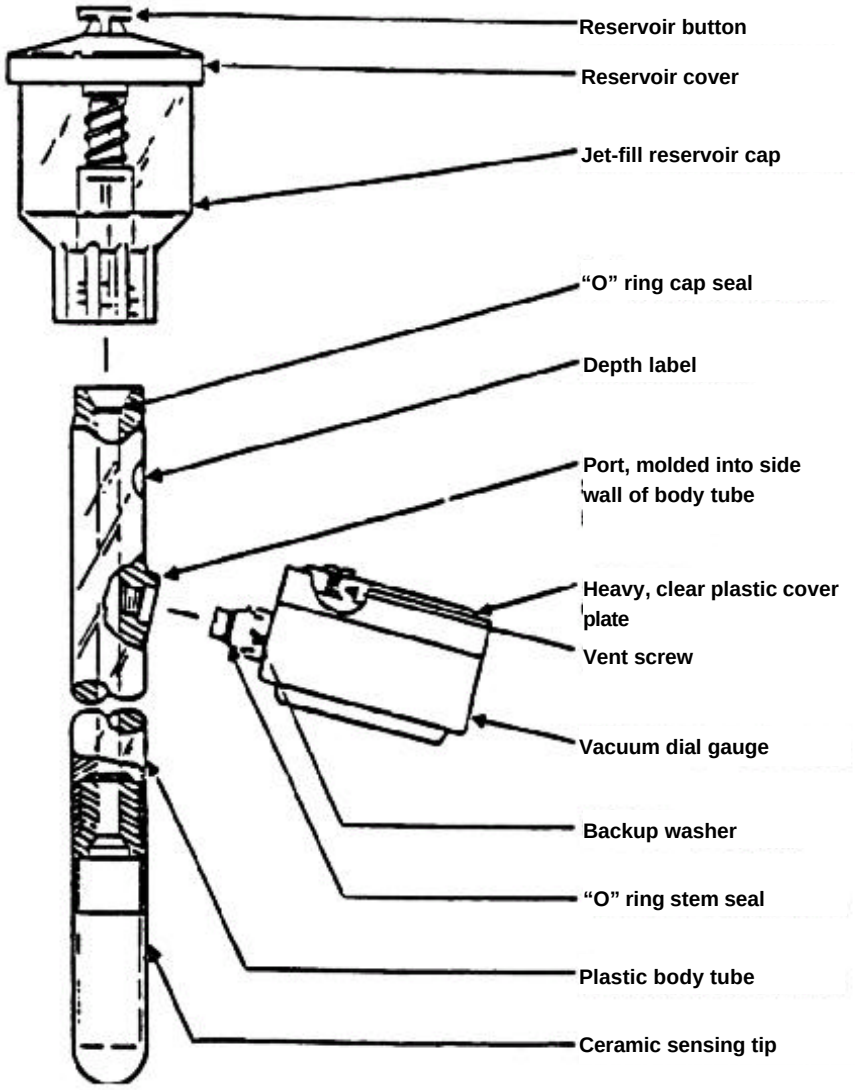
_____ Custody Seals

_____ Unique sample stickers

_____ Sample labels

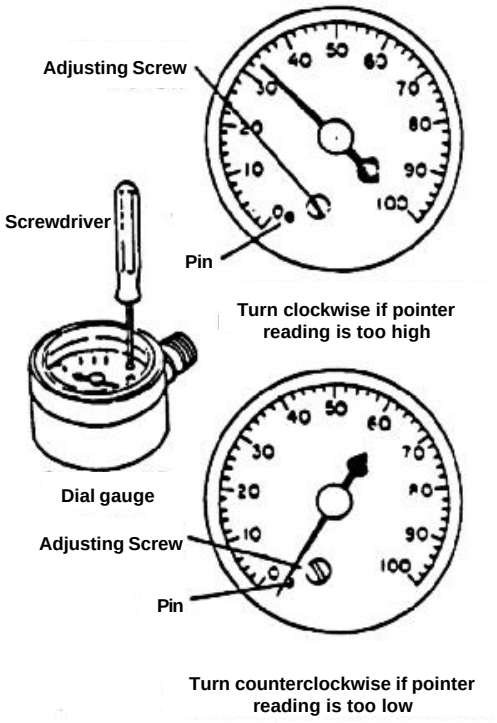
_____ Any additional supplies listed in associated procedures, as needed

Component Parts of a Tensiometer



ER-SOP-6.06	Los Alamos Environmental Restoration Project

Adjusting the Vacuum Gauge Dial



Tensiometer Sampling Field Data

Date/Time: _____ Sheet ____ of ____

Technical Area (TA) _____ Operable Unit _____

Site Work Plan _____

Field Team Member Identification _____

_____

(Print name and title, then sign)

Affix First Sample Sticker Here

Affix Last Sample Sticker Here

Location ID or Description	Sample Identification	Depth Interval (ft)	Pressure Potential (centibars)	Comments

COMMENTS: _____

_____

_____

_____

❑ Check here if continued on the back of this sheet.

ER-SOP-6.06

Los Alamos
Environmental Restoration Project

Tensiometer Sampling Field Data Form Completion

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter “UNK” for unknown, “N/A” for not applicable, or “ND” for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Header Information:

1. Date/Time—The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Sheet Number—Number all the sheets that are used for this activity, by day or by some practical unit.
3. Technical Area (TA)—Two-digit number which indicates the TA in which the activity is being performed.
4. Operable Unit—Four-digit number indicating the Operable Unit in which the sampling is being done or sample is being studied.
5. Site Work Plan—Title of plan.
6. Field Team Member Identification—Print your name and position title, then sign.

Sample Identification:

- If the Daily Activity Log form addresses only one sample, attach a sticker from the batch of stickers that match the sticker number on the sample to the box on the form that reads “Affix First Sample Sticker Here,” and draw a line through the box labeled “Affix Last Sample Sticker Here.”
- If the Daily Activity Log form addresses a sequential number of samples, put the first matching sample sticker in the box marked “First” and put the last matching sample sticker in the box marked “Last.”
- If the sample identifiers used are not sequential, be sure to affix the lowest sample sticker number in the “First” box, record the remaining sample identifiers on the form and Daily Activity Log form, and draw a line through the “Last” box.
- Weather and Other Comments—Record all other conditions pertinent to the sample collection in this section on the Daily Activity Log form.

Sample Characteristics

1. Location ID or Description—Identify the location where the sample was gathered. Follow the Sampling and Analysis Plan (SAP) for specifics on how to properly identify a sampling location.
2. Sample Identification—Sample number as assigned according to instructions in ER-SOP-1.04.
3. Depth Interval (ft)—The depth from which the soil suction measurement was taken. The depth interval is measured in feet and tenths of feet from the land surface.
4. Pressure Potential (centibars)—The expression of the pressure potential relative to atmospheric pressure. The value for this data field is read directly from the gauge.
5. Comments—Observations or information concerning the measurement of soil suction at a specific location.

Comments:

Any additional information.